

## Pediatric tuberculosis consultations across 5 CDC regional tuberculosis training and medical consultation Centers<sup>☆</sup>



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### ABSTRACT

**Background:** The U.S. Centers for Disease Control and Prevention (CDC) funds five Regional Tuberculosis Training and Medical Consultation Centers (RTMCCs) that provide training and consultation for tuberculosis (TB) control and management. RTMCC utilization for assistance with diagnosis and management of TB in children has not been described. We analyzed pediatric TB consultations performed across all RTMCCs in terms of question type, provider type, and setting.

**Methods:** The CDC medical consultation database was queried for consultations regarding patients  $\leq 18$  years provided between 1/1/13–4/22/15 by all RTMCCs (Curry International TB Center, Heartland National TB Center, Mayo Clinic Center for TB, New Jersey Medical School Global TB Institute, Southeastern National TB Center). Each query was categorized into multiple subject areas based on provider type, setting, consultation topic, and patient age.

**Results:** The 5 RTMCCs received 1164 pediatric consultation requests, representing approximately 20% of all consultations performed by the centers during the study period. Providers requesting consults were primarily physicians (46.3%) or nurses (45.0%). The majority of pediatric consult requests were from state and local public health departments (679, 58.3%) followed by hospital providers (199, 17.1%); fewer requests came from clinicians in private practice (84, 7.2%) or academic institutions (40, 3.4%). Consults addressed 14 different topics, most commonly management of children with TB disease (19.1%), latent TB infection (LTBI) (18.2%), diagnosis or laboratory testing (18.7%), and pharmacology (9.2%).

**Discussion:** Pediatric consultations accounted for approximately 20% of all consultations performed by RTMCCs during the study period. RTMCCs were utilized primarily by public health departments regarding management of TB disease, LTBI, and diagnosis or laboratory testing. The relative underutilization of the RTMCCs by clinicians in non-public health settings, who often manage children with TB exposure or infection, warrants further study. As US TB case rates decline and providers become less experienced with childhood TB, medical consultation support may become increasingly important.

### Introduction

There are five Regional Training and Medical Consultation Centers (RTMCCs) funded by the Centers for Disease Control and Prevention

(CDC) in the United States: Curry International Tuberculosis Center, Mayo Clinic Center for Tuberculosis, Heartland National Tuberculosis Center, Southeastern National Tuberculosis Center, and the Global Tuberculosis Center at Rutgers, State University of New Jersey. These

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centers develop educational materials about tuberculosis (TB), support regional TB programs through educational activities including case management training, and provide electronic and telephone medical consultation regarding all aspects of TB control, including TB diagnosis and management, to providers in the US and abroad. All consultations provided by the RTMCCs are captured in the CDC's Medical Consultation Database (MCD), which was created in September 2006. To date, no study has evaluated RTMCC utilization for pediatric cases. Similar evaluations of a variety of consultation modalities, including teleconsultation, internet, and video-assisted methods, in diverse fields of medicine, have led to improvements in quality of care [1–6]. Knowledge about how consultation services are being used would allow RTMCCs to adapt TB training programs and materials to better fit the needs of medical providers and their patients.

We suspect that medical consultation for pediatric TB diagnosis and management of both latent and active TB may be increasingly important as TB rates in the United States decline. Despite decreases in TB incidence, TB in young children remains a concerning health problem. In the United States in 2015, 440 of 9,557 TB cases (4.7%) were in children aged 0–14 years old [7]. Many aspects of pediatric TB have not been well studied, and the diagnosis and management of pediatric TB is often based on “expert opinion,” or is extrapolated from adult studies. As case rates of pediatric TB decline in the United States, providers have less experience managing children with TB, who pose diagnostic challenges because they often present with nonspecific symptoms and do not produce adequate sputum samples for diagnostic purposes, and frequently have paucibacillary and culture-negative TB disease [8,9]. Furthermore, there are few TB drug formulations for children, and administration of TB medications and monitoring for medication toxicities can be difficult in children and quite variable depending upon age [9]. Pediatric TB is also a marker for recent TB transmission, making contact investigations critical for optimizing TB prevention and control efforts [10]. Identifying clinical and demographic factors associated with pediatric TB consultation would help RTMCCs better understand the needs of their stakeholders in order to impact TB prevention and control. This knowledge can help public health programs prevent transmission, latent TB infection (LTBI), and progression to disease in young children [11].

The objective of this study was to assess how RTMCCs are being utilized for pediatric TB consultations by describing requesting provider type and practice setting, patient age, and consultation topic. We also compared utilization among all five RTMCCs.

## Methods

We queried the MCD for medical consultations regarding patients  $\leq 18$  years that occurred between Jan 1, 2013 and April 22, 2015 at all 5 RTMCCs. All data provided were de-identified. Each query was categorized by requesting provider profession and setting, age of the patient, and the consultation topic. Nineteen consultations concerning subjects  $> 18$  years of age were excluded from all analyzes except tabulation of consultation topics, as data about topic areas were not broken down by subject age. For the analysis of consultation topics, a query that addressed multiple topics was counted multiple times. In all other analyzes, a query was counted only once. This study was determined to be exempt from IRB review by the Mayo Clinic Institutional Review Board.

## Results

Across all 5 RTMCCs there were 1,164 pediatric consultation requests during the study period, representing 20% of all adult and pediatric consultations. The majority of these consultation requests were from physicians (46.3%), followed by nurses (45.0%) (Fig. 1). Providers requesting consultation most commonly worked at local or state public health departments (58.3%), followed by hospitals (17.1%), private

practices (7.2%), or other settings (14.1%) including community health centers, correctional facilities, and regional health offices (Fig. 2). Consultations were categorized into 10 different topic areas, which were not mutually exclusive (Fig. 3). The top three topic areas for which consultation was provided were TB disease (19.1%), diagnostic testing (18.7%) for TB disease or LTBI through tuberculin skin test (TST), interferon-gamma release assay (IGRA), or other methods, and LTBI (18.2%). Queries about contact investigation/transmission (11.4%), pharmacology (9.22%), drug resistance (6.94%), case management (5.37%), adverse effects (3.37%), and, program/policy (2.28%) were less common (Fig. 3). The top age category for consultations was children aged 1–3 years (19.0%), followed by  $\leq 1$  year (17.0%), 3–5 years (12.0%), and 13–18 years (11.0%) (Fig. 4). Consults were less commonly about school age children 5 to  $< 10$  years (7.0%) and 10–13 years (6.0%). Consultations regarding children of multiple ages comprised 7.0% of all queries. Approximately 21.0% of the consultations did not specify age of the patient(s).

There were no differences across all 5 RTMCCs in terms of provider setting, consultation topics, or patient age group. However, the proportion of all consultations that were pediatric varied across centers, ranging from 14% to nearly 40% (Table 1). In addition, there were differences among the five centers in distribution of requesting provider type: Heartland and Mayo received consultation requests primarily from nurses, while Curry, Southeastern, and Global TB Institute received consultation requests primarily from physicians.

## Discussion

Our findings demonstrate that pediatric consultations represent a significant proportion of consultations provided by the five RTMCCs. Public health departments are the main users of RTMCC pediatric consultation, primarily regarding TB disease, diagnostics, and LTBI. We observed fewer consultations from non-public health entities than from public health providers. As children with LTBI may be treated by private providers, academic institutions, and hospitals, RTMCC consultation services might be better marketed to these non-public health entities in order to achieve the best outcomes for these pediatric patients [12].

Consultations for pediatric TB, including TB disease, LTBI, infection control, contact investigation and programmatic policy issues, represented 20% of overall consultations provided by RTMCCs during the study period. Although the definition of pediatric patients is  $\leq 14$  years in the National TB Surveillance System compared with  $\leq 18$  years in the RTMCC MCD, the proportion of pediatric RTMCC TB consultations (20%) is 4 times higher than the proportion of pediatric TB cases in 2015 (4.7%) [7], suggesting that RTMCCs are being utilized disproportionately for pediatric patients. In young children, both LTBI and active TB can be more difficult to diagnose, LTBI is more likely to progress to active TB, and TB is likely to manifest in more extreme forms such as meningitis or disseminated disease, thereby creating a need for consultation [13].

Our data suggest that the 5 RTMCCs have the potential to impact the care of the youngest children (1–3 years), who are at highest risk for progression to TB disease. The fact that providers frequently ask questions about the diagnosis and management of pediatric TB and LTBI suggests that there is both a paucity of providers with experience in pediatric TB management and a need for further training and education for providers caring for children with TB, many of whom may not be pediatricians.

TB diagnosis in pediatric patients is challenging for many reasons, including the high frequency of culture-negative disease in children. Additionally, infants with active TB often will present with extrapulmonary disease, young children with pulmonary TB may not cough or produce high quality sputum samples, and pediatric TB tends to be paucibacillary, often resulting in negative acid fast bacilli (AFB) smears on respiratory and gastric acid samples. Furthermore, there is much

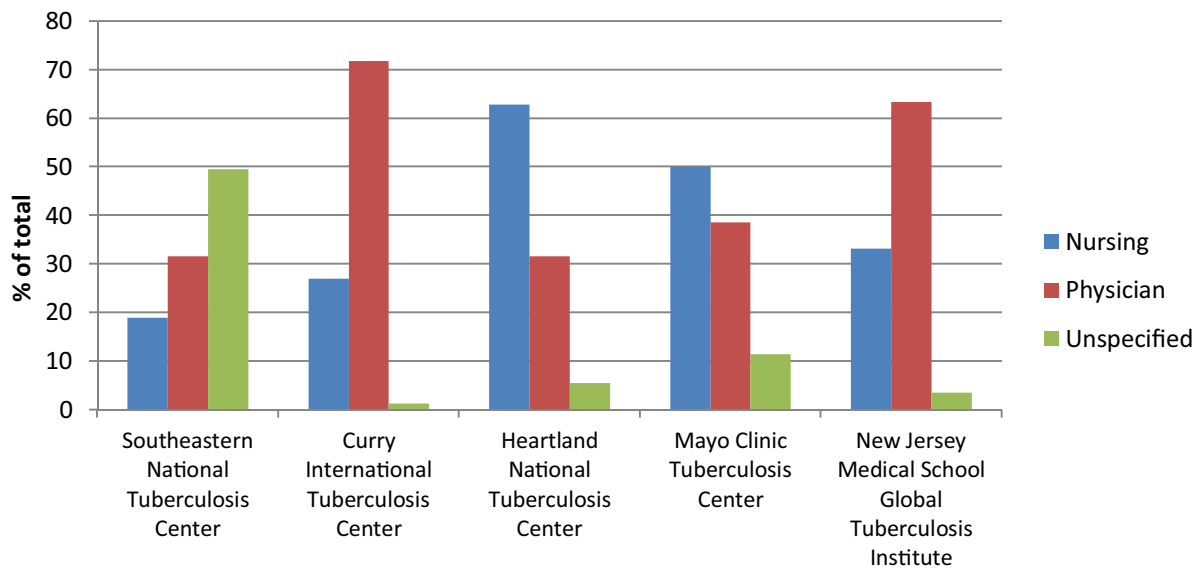


Fig. 1. Distribution of provider types requesting RTMCC consultation for patients ≤ 18 years of age between 1/1/13 and 4/22/15. % of total consultations at each RTMCC is shown. Provider type was unspecified in 101/ 1164 (8.6%) of consultations.

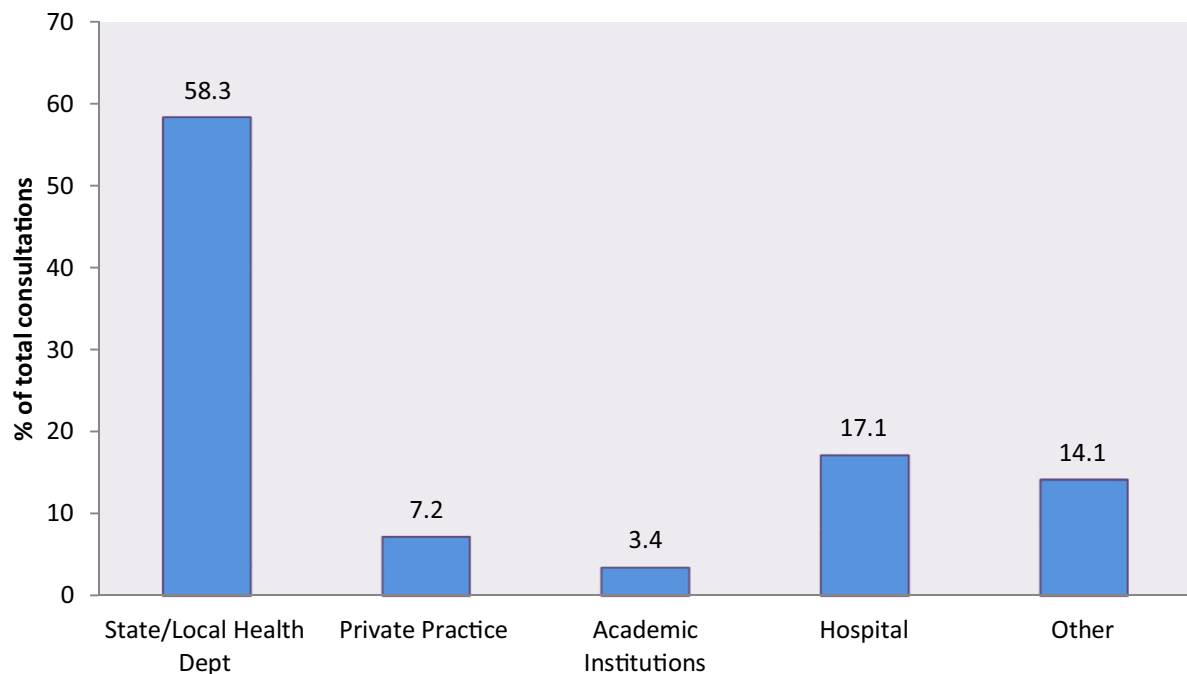
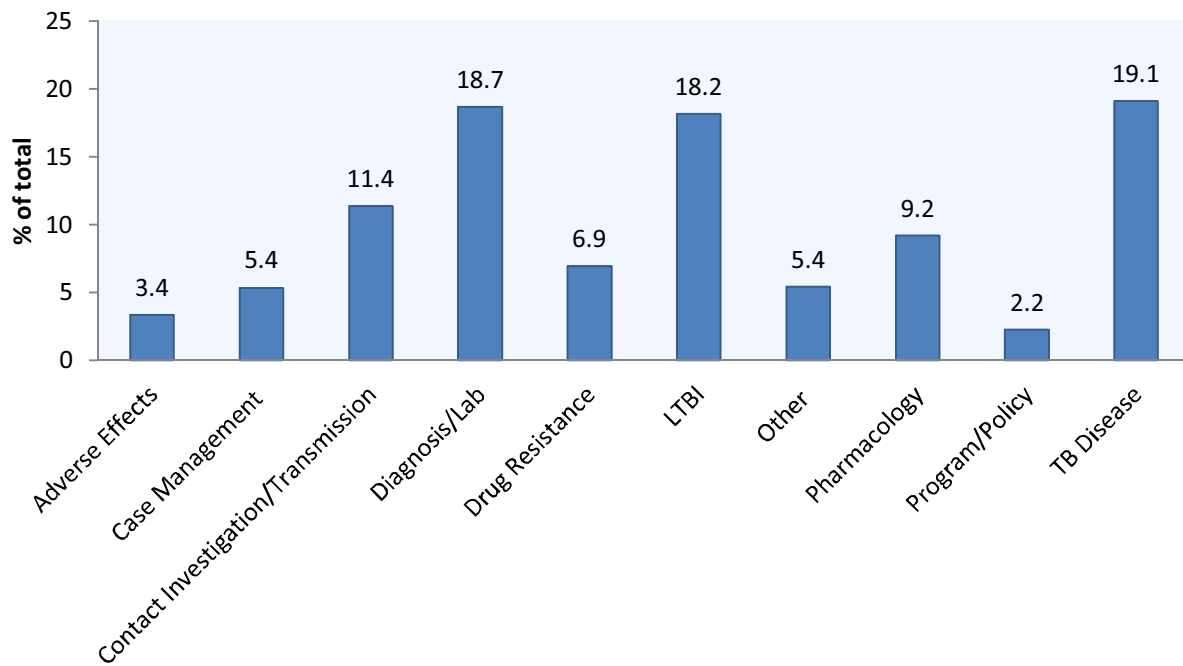


Fig. 2. Setting of providers requesting pediatric consultations from RTMCCs between 1/1/13 and 4/22/15. % of 1164 consultations is shown. Other includes regional health offices, community health centers, and corrections facilities.

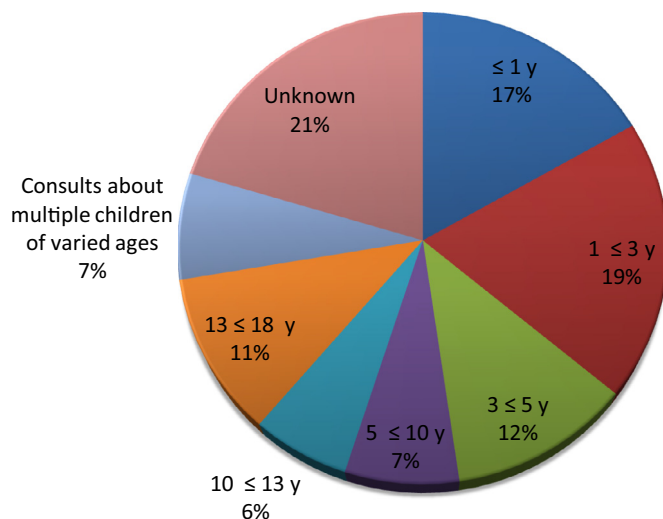
uncertainty regarding the test performance of the tuberculin skin test vs. interferon-gamma release assays in children under 5 years of age, particularly those that are BCG-vaccinated, and the preferred test for LTBI in children of different ages remains unclear [13]. Such confounding issues may explain why clinicians had frequent questions concerning TB diagnosis, a topic that comprised 18.7% of all consultations. Similarly, management of childhood TB infection and disease is difficult because there are few clinical studies addressing dosing and route of administration of TB medications in children, young children tend to have nonspecific symptoms, and are more likely than older patients to present with advanced TB, including disseminated TB or TB meningitis [14]. Consequently, questions pertaining to pharmacology (9%) and TB disease (19%), and LTBI (18%), were common. The fact that contact investigation/transmission made up 11.4% of all

consultations is encouraging, as limiting transmission is an important aspect of TB prevention.

A major difference in utilization across the 5 RTMCCs was the type of provider requesting consultations. Nurses were the most frequent users of the two RTMCCs located in the Midwest: Heartland National TB Center and Mayo Clinic Center for TB. In contrast, physicians more frequently consulted the other three centers. We speculate that this difference may be a result of geographic differences, as larger numbers of TB cases occur on the coasts, and in urban areas, leading to increased experience among providers, and consequently, greater numbers of physicians treating TB cases. Another possibility is that nurses and physicians could be seeking different kinds of consultation. Some RTMCCs provide on-going and case management consultation, while others, per internal protocol, more often provide one-time consultation.



**Fig. 3.** Topic areas of pediatric consultations provided by RTMCCs between 1/1/13 and 4/22/15. 1164 consultations were categorized into 1 or more topic areas, yielding a total of 2104 consultations. Data include 19 patients > 18 years of age. Other category includes legal issues, nontuberculous mycobacteria and Human immunodeficiency virus (HIV)/TB. Diagnosis/lab category includes tuberculin skin test (TST) and interferon-gamma release assay (IGRA). Drug resistance category includes multidrug-resistant (MDR) and extensively drug-resistant (XDR) TB.



**Fig. 4.** Patient age among 1164 pediatric consultations provided by RTMCCs between 1/1/13 and 4/22/15.

**Table 1**  
Pediatric and adult consultations performed at each regional tuberculosis training and medical consultation center (RTMCC), 1/1/13–4/22/15.

RTMCC	Pediatric	Adult	Total Consults	% Pediatric
Curry International Tuberculosis center	242	633	875	27.7
Heartland national Tuberculosis center	482	2677	3159	15.3
Mayo Clinic Tuberculosis center	159	581	740	21.5
New Jersey medical School global Tuberculosis institute	204	312	516	39.5
Southeastern national tuberculosis center	67	406	473	14.2
All centers	1154	4609	5763	20.0

As knowledge about TB diminishes among US clinicians, medical consultation may be moving more towards a longitudinal clinical and case management role.

Our study had several limitations. We lacked feedback about the RTMCC service from the providers who requested consultations. Each RTMCC is currently collecting information about whether consultations were helpful and if recommendations were implemented, which is critical for improving the quality of consultation and will be the basis of future studies. We also did not collect patient outcomes data and, therefore, do not know if patients with RTMCC consultation had better outcomes than patients without. We were unable to separate nurse practitioners from nurses in our dataset. Standard definitions of TB consultation topic areas do not currently exist, so topic areas may have been misclassified. We could not account for variability in how consultations are provided and documented across RTMCCs. Because we obtained de-identified data from the MCD, we were unable to determine if there were multiple consultations regarding the same patient, and thus the 1,164 consultations may not reflect unique patients. Lastly, we could not account for missing data, including patient age, and it is possible that many consults are not documented if the call goes directly to a provider who does not create an MCD entry.

Despite these limitations, we observed that all 5 RTMCCs were used frequently for pediatric TB consultations during the study period, primarily by public health departments regarding diagnosis, initial treatment and management of TB disease. RTMCCs were relatively underutilized by clinicians in other settings. Our findings suggest that providers in public health and other settings would benefit from increased education about diagnosis and management of childhood TB. Increased awareness of the expertise that is currently available at 5 regional centers would also benefit clinicians practicing in private practice, academic, and hospital settings who may infrequently manage pediatric patients with TB disease or LTBI, which would ultimately improve both the knowledge and capability of those providers as well as the health outcomes of their patients. As U.S. TB-case rates decline and providers become less experienced with the complexity of childhood TB diagnosis and management, medical consultation may play an

increasingly important role in TB prevention and control.

### Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the authors' affiliated institutions.

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